



BURRAY

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HARDMETAL SPECIALIST

**BURRAY**

**PRECISION  
WEAR PARTS**

Sichuan Burray Cemented Carbide Co., Ltd.



# About Us

Sichuan Burray Cemented Carbide Co., Ltd.

BURRAY has complete production line for cemented carbide precision dies and finished products. Besides, we have imported high-end devices for manufacturing, processing, and inspection, such as Agathon, Schneeberger, Moore Tool, Alicona, etc. At the same time, we are continuously optimizing product construction, adjusting business strategy, investing more on R&D, cultivating technical personnel, establishing and perfecting strict inspection and analysis process, improving product precision and quality as a result.

BURRAY has independent import and export rights. Our products have been passed and are strictly enforced international certification standard for cemented carbide products all the time. High-end devices, super technical skills, perfect team, high-quality products, and satisfying service are our foundation to be a leader in the domestic market. Also, we commit to being a well-known cemented carbide enterprise in the world. So far, our products have been exported to the USA, Russia, India, Japan, etc and enjoyed customers' consistent praise.

BURRAY Adheres to responsible and sustainable business practices, including conflict free raw material sourcing, proactive health management for our employees, and continuous concern about the environmental impacts of our business. Our open and transparent business philosophy allows our customers, employees, and external suppliers, to have confidence in our business, ways of working, and our products.

SICHUAN BURRAY CEMENTED CARBIDE CO., LTD. is a professional high-tech enterprise, specialized in high-performance carbide R&D, design, manufacture, marketing sales, products including cemented carbide precision dies, cutting tools, wear-resisting parts, carbide profiles, etc. It covers an area of over more than 20 mu with 7,800 sq.ft standard workshop and 5'500 sq.ft R&D office. Anbang has many high-quality technical and management personnel who have strong technical strength and rich processing production experience. We are able to make different kinds of special customized cemented carbide products with  $\pm 0.002$ mm machining precision. Our products are widely applied to the following fields: machine manufacturing, metallurgy, mining, oil, electronics, space industry, etc.



## QUALITY CONSISTENCY EXPERTISE

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# Product Process Flow

## 01. Grade Design

BURRAY grades are designed upon application. Our process start with powder mixing. Raw materials includes WC, Co and other elements.



## 02. RTP Ball milling

Wide variety of BURRAY designed grades from superfine to coarse grain size are available.

Grades with different grain size are ball-milled, sieved, granulated in separated systems to avoid grain contamination.



## 03. Spray Drying

Spray drying process makes the powder into superior homogeneous particle sizes with good flowability and as a result, the dimension variation on sintered blank is much smaller.



## 04. Injection Moulding



## 05. Direct Pressing

This process removes the plasticizer in the rod blanks using a vacuum drying furnace.

## 06. HIP Sintering

Green blanks sinte red at temperature around 1400 °C (cobalt melting) to become super hard and tough.

BURRAY utilizes HIP (hot isostatic pressure) sintering furnace which gives carbide maximum toughness to meet the most critical working applications.



## 07. Machining

Most of the rod blanks need to be centerless ground, to achieve precision tolerances h6/h5.

In addition, length cutting, chamfer, slot, cylindrical grinding service can be offered upon customer request.



## 07. Finishing Process



## 08. Inspection

The key properties are monitored from raw material, RTP and raw sintered parts in our laboratory for quality and performance guarantee.

Dia meter, roundness, run-out, roughness, pitch, TK, concentricity, inspection will be done before the parts are shipped to the customer.



# Product Inspection and Testing



## BURRAY CARBIDE



# Brand Name

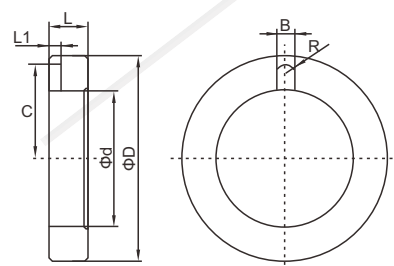
Grade	Mechanic Properties					Material features and recommend applications
	Hardness (HRA)	Transverse Rupture Strength N/mm <sup>2</sup>	Thermal Expansioncoef Ficient (×10 <sup>-6</sup> /°C)	Wear Of Abrasive Grain (cm3/100000r)	Impact Toughness (N·m/cm <sup>2</sup> )	
YG5	93.1	2500	5.0	0.06	4.7	Superior wear resistance, good comprehensive properties, suitable for making non-standard structure components with higher wear resistance.
YG15	87.5	3300	5.5		5.5	Good strength and impact toughness, suitable for making non-standard structure and mechanic components in working conditions of large stress.
YG9C	88	3000	5.3	2.2	6.5	Good wear resistance, high strength, suitable for nozzles and sleeves of water spray hole of PDC drill bits and cone roller bits.
YG11C	87.3	3100	5.4	2.8	6.8	Better wear resistance, good impact resistance, suitable for high pressure nozzles in the petroleum, chemical and mechanic industries.
YG20C	83.5	2600	6.1		8.5	Optimal strength and impact, toughness, suitable for making non-standard structure and mechanic components in working conditions of very large stress.
ZLT10	89.5	2000	—	1.8	5.5	Good wear, corrosion and thermal shock resistance, non-magnetism, light specific gravity, high pumping effect, suitable for making valve ball, valve seat of back pressure valve of oil raising pump.
Zk30 (Yg8)	90.2	3000	5.1	1.4	3.2	Good wear resistance, high strength, suitable for making non-standard structure and mechanic components under working conditions of normal stress.
ZK35.5	87.3	2900	5.3	4.0	5.2	Good corrosion resistance and strength, suitable for impact resistant seal-ring.
ZN106G	91.5	2500	5.0	1.6	4.8	Good wear and corrosion resistance, suitable for making parts of corrosion resistant submerged oil pump and acid proof pump.
ZN109G	90.5	2800	5.4	1.9	5.4	Good wear and corrosion resistance, suitable for making parts of the drink water pump.
ZN211G	88.6	3000	5.2	3.2	5.1	Good corrosion resistance, high strength, suitable for making parts of corrosion and impact resistant submerged oil pump.
ZK10UF-1	92	2900	5.0	0.9	3.9	Good wear resistance and strength, suitable for making parts of standard and deep-sea submerged oil pump.
ZK30UF	91.7	3100	5.4	0.6	7.6	Higher wear resistance and strength, suitable for making impact resistant non-standard structural and mechanic components.



# Cemented Seal-ring

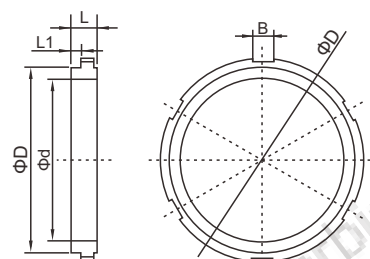
Precision tungsten carbide seal rings is achieved by mixing the ultra fine powders and advanced working process, to make sure the rings qualified with an extremely hard and tough property, commonly used in sewage pumps, mine drainage pumps, centrifugal pumps, centrifuge and mud pumps. The precision sealing rings with different binder content can be used in different working conditions like high speed rotating, high pressure, high ( low ) mild acid, alkaline corrosion liquid, etc.

## Dimensions of Precision Seal-ring



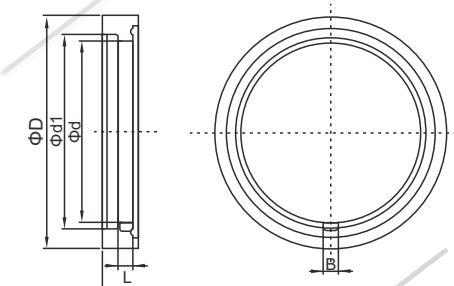
**basic dimensions (mm)**

ΦD	Φd	L	L1	B
35	23	7	2	3



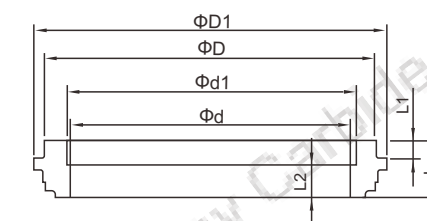
**basic dimensions (mm)**

ΦD	ΦD1	Φd	L	L1	B
105	115	92	15	6	12



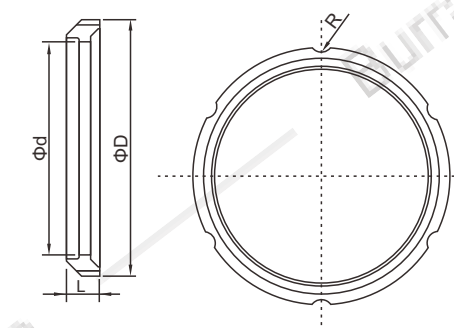
**basic dimensions (mm)**

ΦD	Φd	Φd1	L	L1	B
96	75	80	15	7	6



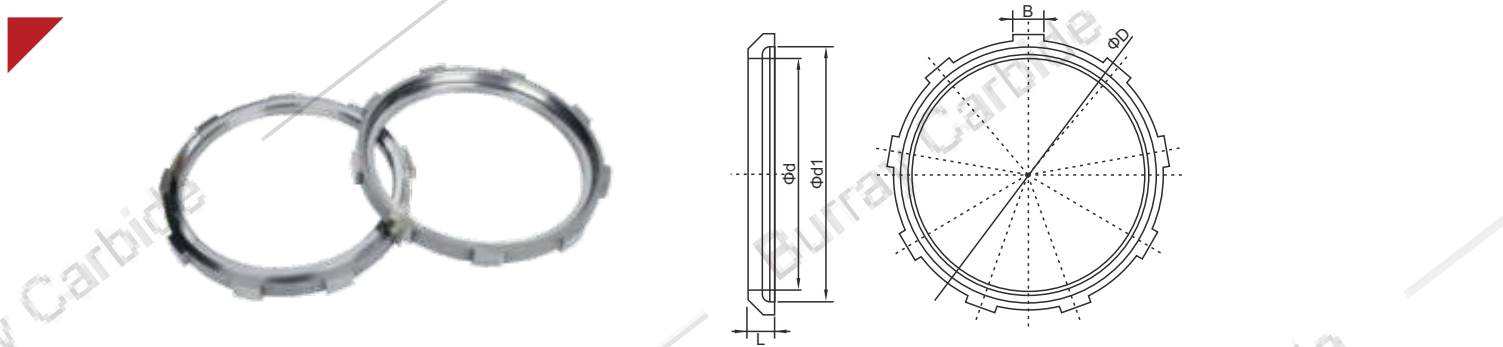
**basic dimensions (mm)**

ΦD	ΦD1	Φd	Φd1	L	L1	L2
145~175	155~185	123~159	127~163	22~25	8~10	12~15

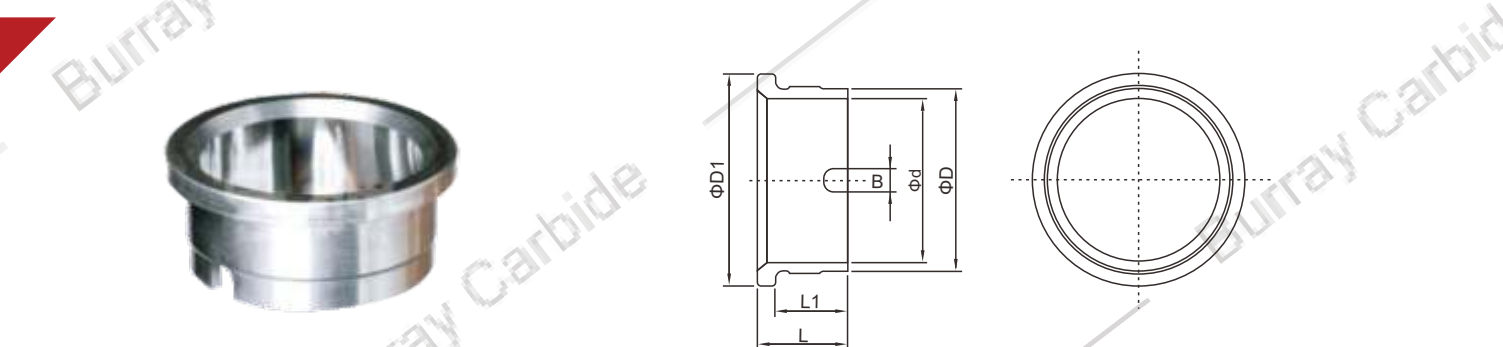


**basic dimensions (mm)**

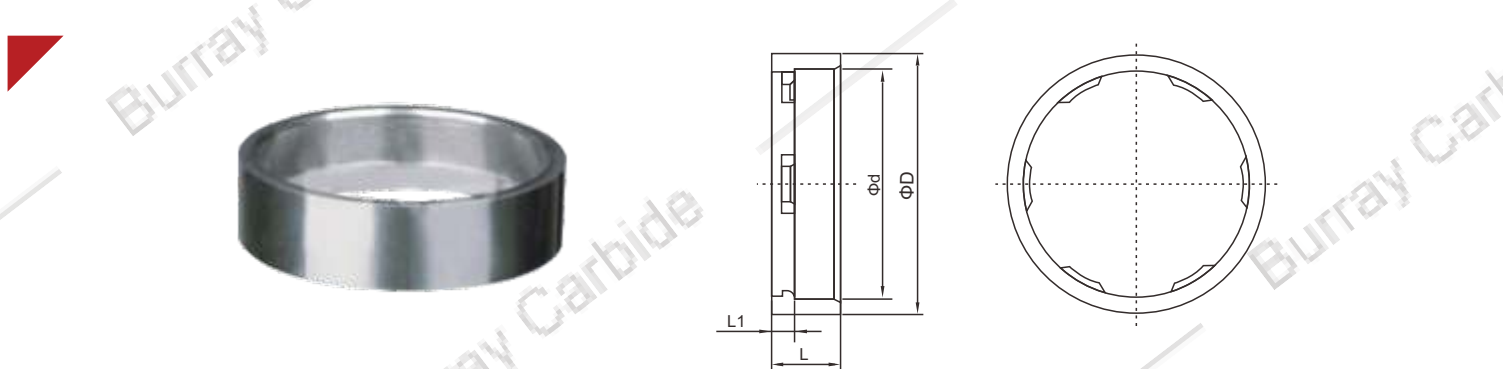
ΦD	Φd	R	L
144	120	5	18



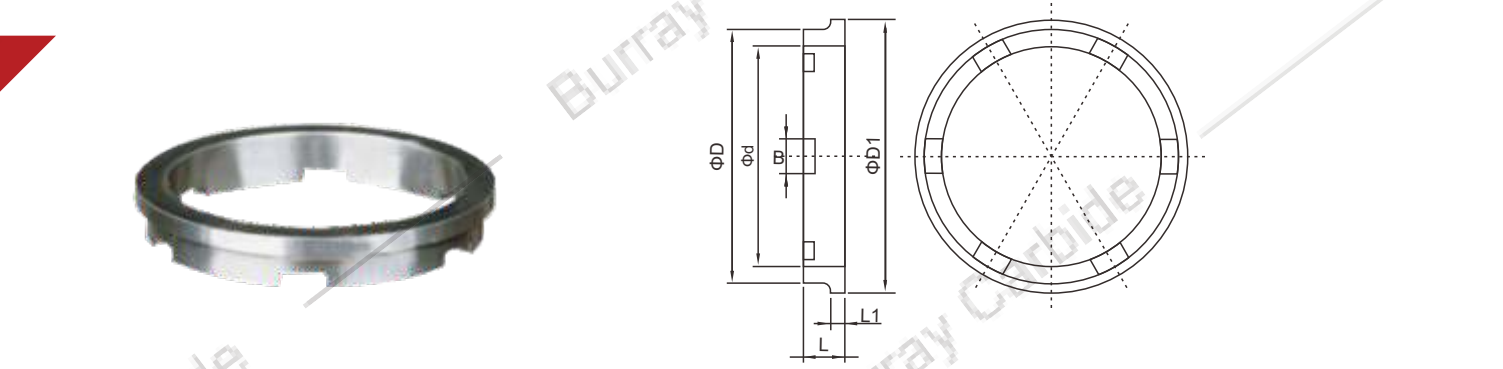
basic dimensions (mm)				
$\phi D$	$\phi d$	$\phi d1$	L	B
111	90	100	11	12



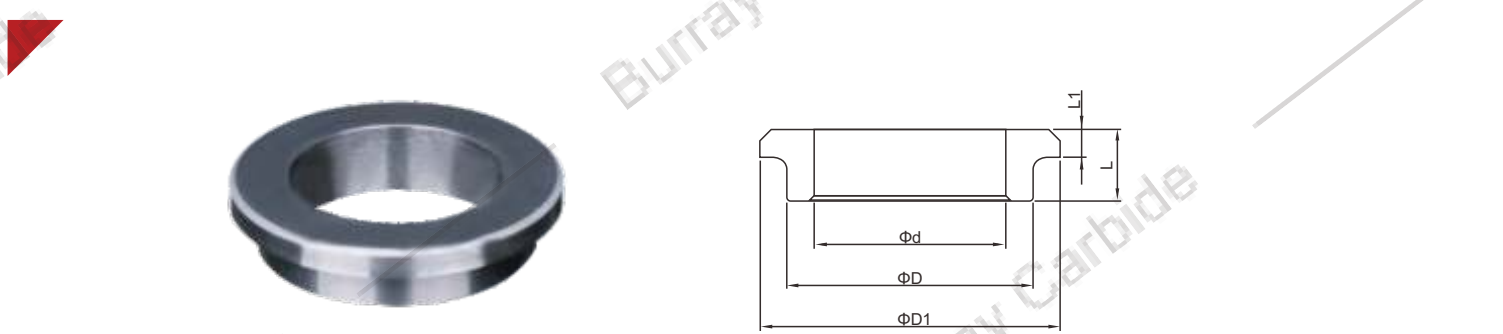
basic dimensions (mm)					
$\phi D$	$\phi D1$	$\phi d$	L	L1	B
41	48	36	21	17	



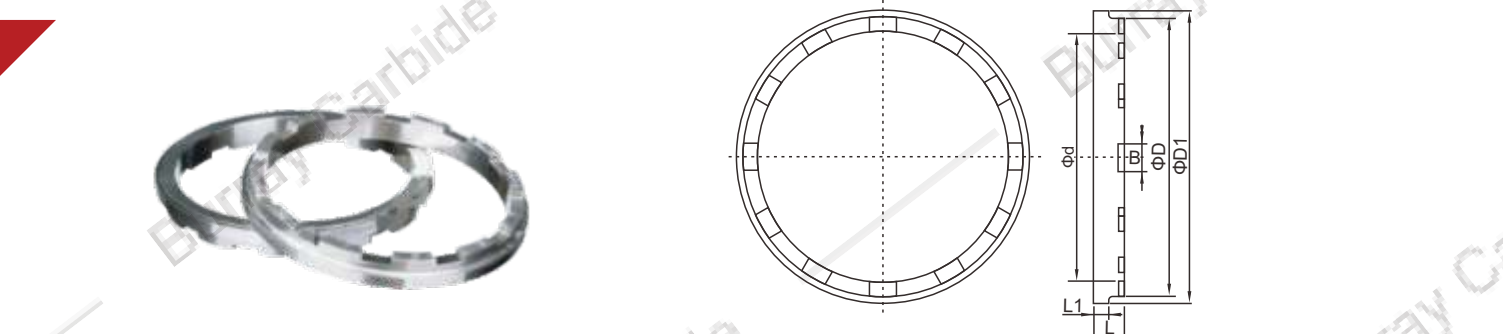
basic dimensions (mm)			
$\phi D$	$\phi d$	L	L1
55	49	15	5



basic dimensions (mm)					
$\phi D$	$\phi D1$	$\phi d$	L	L1	B
41~53	46~57	36~46	7~9	3	5~7



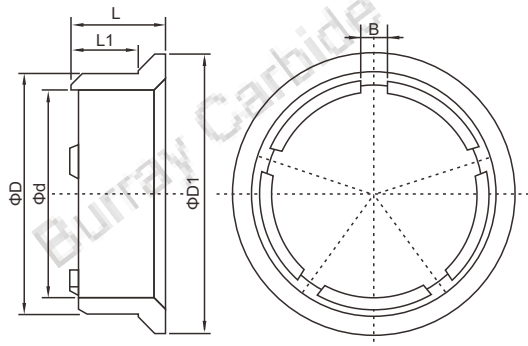
basic dimensions (mm)				
$\phi D$	$\phi D1$	$\phi d$	L	L1
29	36	20	8	3



basic dimensions (mm)					
$\phi D$	$\phi D1$	$\phi d$	L	L1	B
68~103	73~109	61~92	10~12	4~6	8~10

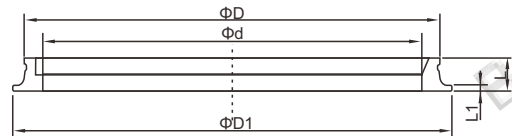


Dimensions of Precision Seal-ring



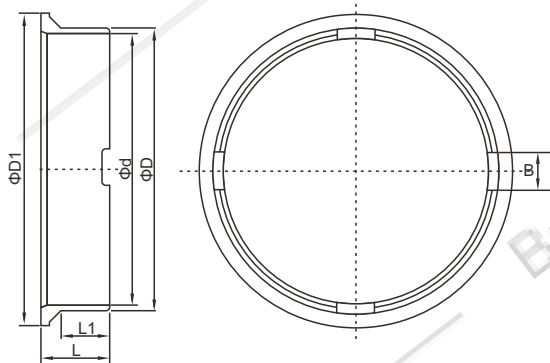
basic dimensions (mm)

ΦD	ΦD1	Φd	L	L1	B
28~34	34~39	23~29	14	9	7



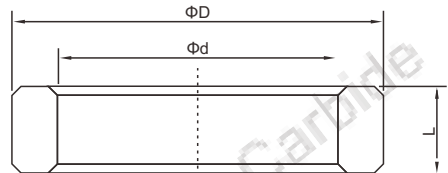
basic dimensions (mm)

ΦD	Φd	Φd1	L	L1
61	65	55	5	0.8



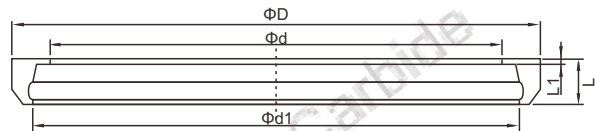
basic dimensions (mm)

ΦD	ΦD1	Φd	L	L1	B
90~92	97~100	82~86	22~30	16~19	12



basic dimensions (mm)

ΦD	Φd	L
28~150	20~120	6~15



basic dimensions (mm)

ΦD	Φd	Φd1	L	L1
65	55	60	5.6	0.8

Technic Parameters

unit:mm

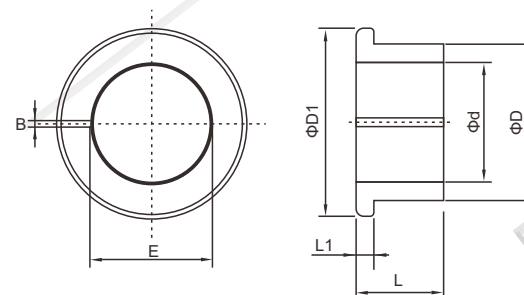
flatness	surface roughness Ra	surface roughness Rz	shape of seal face
≤0.6	0.03~0.06	0.5	plane concave/convex sphere

# Cemented Carbide Sleeves

The cemented carbide shaft sleeves play the role of locating or positioning, supporting and protecting the rotational shafts from wearing. It possesses superior wear resistance, low friction coefficient, good toughness and long service life. They are widely used as wear parts in various machinery, such as motorized equipment, hydraulic systems and oil well artificial lift systems like electric submersible pumps (ESPs), centrifugal pumps, and other turbo machinery.

## Dimensions of Precision Seal-ring

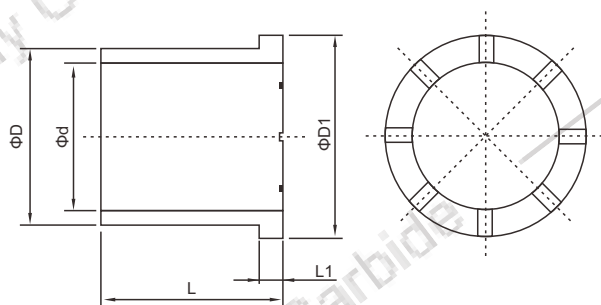
ESP Shaft Bushing with keyway



basic dimensions (mm)

ΦD	ΦD1	Φd	L	L1	B	E
20~40	24~63	15~36	11~42	2~7	1.6~3.2	18~31

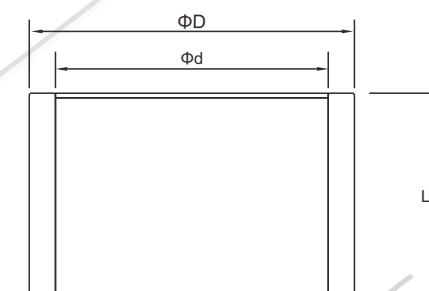
T-shaped Shaft Sleeve with Oil Grooves



basic dimensions (mm)

ΦD	ΦD1	Φd	L	L1
46~57	52~64	38~48	26~38	6~10

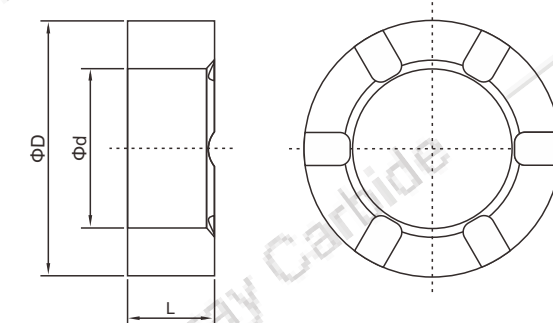
Straight Sleeve



basic dimensions (mm)

ΦD	Φd	L
24~122	15~114	5~65

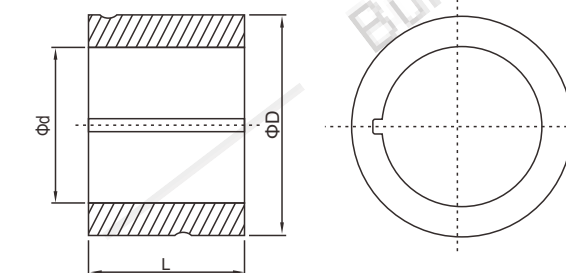
Straight ESP Sleeve Bearing with Oil Grooves



basic dimensions (mm)

ΦD	Φd	L	R
24~41	15~29	8~15	2.5

Sleeve With Spiral Groove



basic dimensions (mm)

ΦD	Φd	L
24~122	15~114	5~65



# Carbide Shaft Sleeves

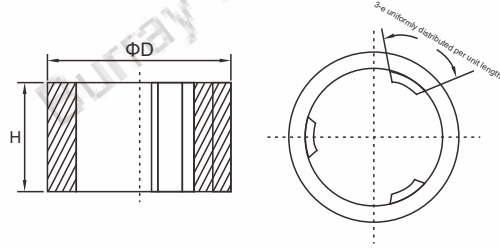
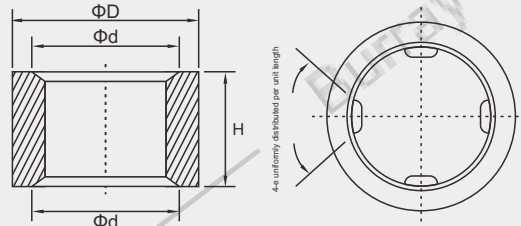
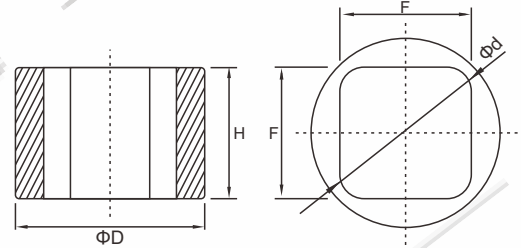
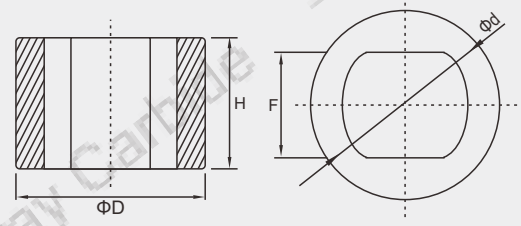
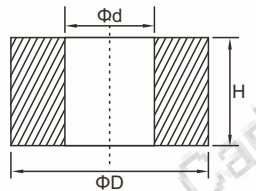
Carbide shaft sleeves are tough wear, wear-resistant and corrosion-resistant bearings for pumps and motors. They are much more durable than the sleeves made of copper, stainless steel, or cast iron. Carbide sleeves are mainly used in multistage centrifugal pumps for water supply in skyscraper, water treatment, fire fighting, etc.

## Mechanic Properties of Common Cemented Carbide Grades for Precision Wear Parts

Grade	Density (g/cm <sup>3</sup> )	Hardness (HRA)	Transeverse rupture strength (Nmm/2)	Material characteristics
AN100	14.75~15.0	91.0~92.5	2000(2500)	Excellent wear resistance, suitable for use in oil, sewage, weak acid and weak base, granular medium.
AN200	14.5~14.9	90.5~92.0	2100(2800)	
AC100	14.5~14.8	89.0~92.0	1800(2000)	Good wear resistance and corrosion resistance, suitable for oil, sewage, weak acid and alkali, sea water, granular medium use.
AC200	14.4~14.8	88.0~91.0	2000(2300)	
AKT50	8.9~9.5	89.5~92.0	1600(2000)	Good wear resistance, Suitable for oil, sewage, weak acid and weak alkali, light hydrocarbon, small amount of granular medium.

Note: material and structure design can be carried out according to customer drawings and usage requirements.

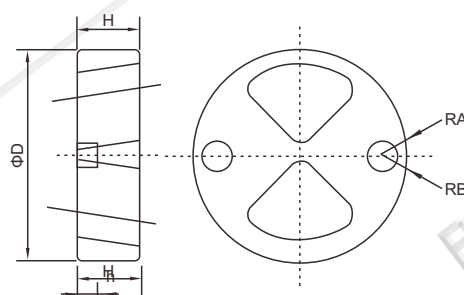
## Dimensions of Precision Seal-ring

Type	Figure	Dimension(mm)		
		D	d	H
Inner petal-3 flaps		14~22	11~17	9~13
Inner petal-4 flaps		18~26	14~18	10~14
Model sleeves		18~24	15~18	10~16
H model sleeves		18~24	14~18	10~16
Straight sleeves		14~25	10~18	10~16

# Carbide Valve Parts

carbide valve trim, such as plugs and seats for choke valves, likely designed by AP16A standard, and is mainly used in blowout preventers for oil or (gas) wellhead. These flow control devices serve. In harsh conditions, typically corrosive and erosive medium containing gas, water, oil, sand, wax, colloid, asphalt and other chemicals. Carbide parts KLT produces for valve trim precision grounded, combined with high hardness for wear resistance, good toughness, and corrosion resistance.

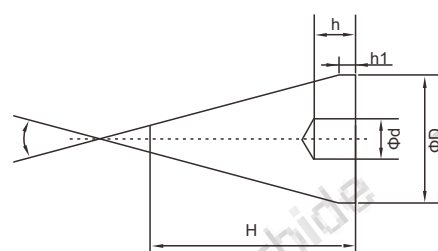
Carbide balls, and seats are is widely used as valves in sucker rod pumps for artificial life of petroleum. According to the physical and chemical properties of the crude oil of particular well, the cemented alloys of titanium carbide or tungsten carbide with binders of either, cobalt or nickel can be selected, For wells of lighter crude oil, balls and seats of stainless steel, ceramic materials can be also used. Carbide balls and seats possesses superior wear resistance, excellent corrosion resistance, and good toughness, which makes them suitable for use in abrasive and high density well condition.



**basic dimensions (mm)**

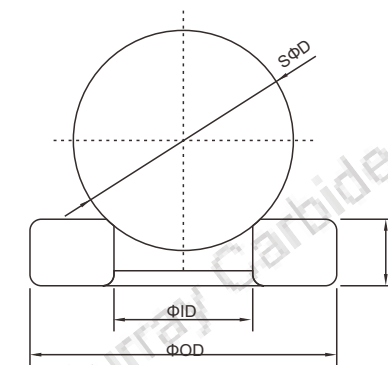
D	H	A	B	C	h
44.5	12.5	6.0	5.0	5.0	6.0

Note:  $\alpha=10^{\circ}\sim13^{\circ}$



**basic dimensions (mm)**

D	d	H	h	h1
28.6	9.65	47.8	9.65	3.35
26.3	8.9	42.2	8.9	3.2



API Code Projects	V-106	V11-125	V11-150	V11-175	V11-200	V11-225	V11-250	V11-375
SΦD	15.88	19.05	23.83	28.58	31.75	34.93	42.88	57.15
H	12.7	12.7	12.7	12.7	12.7	12.7	12.7	19.05
OD	20.14	23.32	29.67	35.26	37.54	43.69	51.05	78.03
ID	11.68	13.97	17.02	20.96	24.38	26.92	33.27	43.18

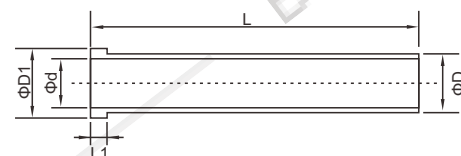
Note: SD is the tolerance of valve ball roundness, with its maximum at 0.003mm, while Ra is surface roughness with its maximum at 0.1um



# Cemented Carbide Nozzles

Cemented carbide nozzles are also called water holes. They are mainly used in drilling tools such as PDC bits and cone bits for oil and gas drilling. The drilling fluid is used to wash, cool, and lubricate the drilling teeth. With high hardness, superior wear resistance and corrosion resistance, they are commonly used in contact with high pressure, high velocity, and vibrational fluids, often mixed with sand. These conditions may also cause erosion, the main mechanism that the nozzles are damaged and scrapped. In order to make the nozzles long lasting, the cemented carbide nozzle with the erosion proof sleeve is particularly designed to maximize its wear life.

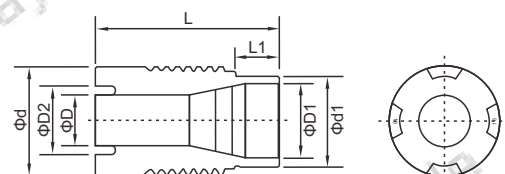
## Nozzles



basic dimensions (mm)

ΦD	ΦD1	Φd	L	L1
15	17	10.3	49	4.1
19	22	14.3	25	3.2
21	22	17.5	31	2.9
21	23.4	14.8	51	4.1
21	24.2	17.5	40	9.5
21	24.2	17.5	60	9.5

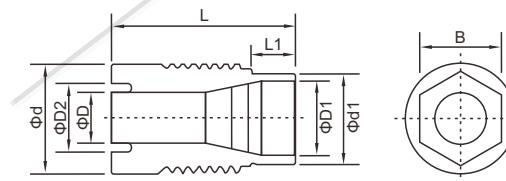
## Threaded Cemented Carbide Nozzle for PDC Drilling Bit



basic dimensions (mm)

No.	ΦD	ΦD1	Φd	Φd1	L	L1
9	7.1	17.5	25.4	20.4	30.8	3.9
10	7.9	17.5	25.4	20.4	30.8	3.9
11	8.7	17.5	25.4	20.4	30.8	3.9
12	9.5	17.5	25.4	20.4	30.8	3.9
13	10.3	17.5	25.4	20.4	30.8	3.9

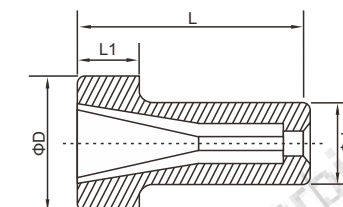
## Thread Nozzle for PDC Drilling Bit with Hexagonal Wrench



basic dimensions (mm)

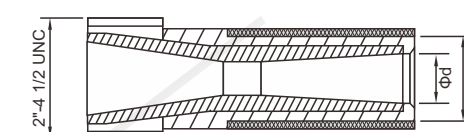
No.	ΦD	ΦD1	Φd	Φd1	L	L1	B
7	5.6	12.7	22.2	17.15	25.4	4.3	15.6
8	6.4	12.7	22.2	17.15	25.4	4.3	15.6
9	7.1	12.7	22.2	17.15	25.4	4.3	15.6
10	7.9	12.7	22.2	17.15	25.4	4.3	15.6
11	8.7	12.7	22.2	17.15	25.4	4.3	15.6
12	9.5	12.7	22.2	17.15	25.4	4.3	15.6

## Nozzles



basic dimensions (mm)

ΦD	Φd	L	L1
30	15	60	10
40	20	70	12
50	25	80	15
60	28	80	18
70	30	90	20



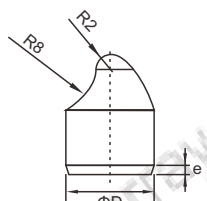
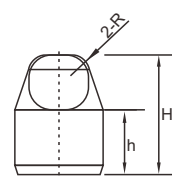
basic dimensions (mm)

ΦD	Φd	L	L1
30	15	60	10
40	20	70	12
50	25	80	15
60	28	80	18
70	30	90	20

# The Carbide Drill Teeth

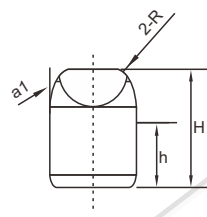
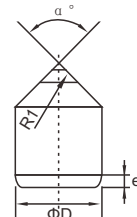
The carbide drill teeth/inserts have excellent abrasion resistance and impact toughness. They are often used as drilling tools in coal mining machinery and road construction equipment, and road maintenance such as snow remover and road sweeper. They are widely used in drill bits, tunnel excavators and grinders, and their accessories.

### Type CB Spoon Buttons



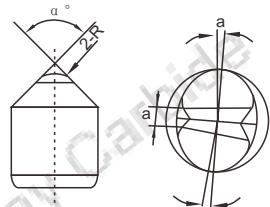
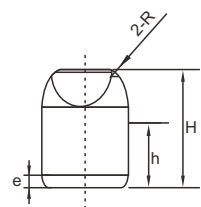
Type	basic dimensions (mm)								
	D	H	R	R1	R2	R3	h	$\alpha^\circ$	e
CB1115	11	11.5	2.5	12	2.5	8	8	18	1.2
CB1217	12	17	2.5	20	2	12	12	18	1.5
CB1418	14	18	3	16	2.5	8	8	18	1.5
CB1420	14	20	2.5	13	4	5	5	18	1.5
CB-00007	19	30	3	22	3	16	16	14	2

### Type BA Wedge Buttons



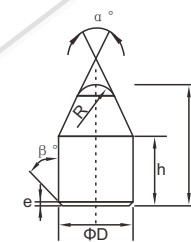
Type	basic dimensions (mm)							
	D	H	h	R	R1	α°	a1	e
BA0811	8	11	7.5	1.5	1.5	90	15°	1.2
BA1217	12	17	10.5	3	3	70	22°30'	1.5
BA1418	14	18	12	3.5	2.5	90	22°30'	1.5
BA1419	14	19	11	4.5	3.5	65	20	1.5
BA1929	19	29	17	3.5	3.5	65	15°	2

### Type AC Eccentric Wedge Buttons



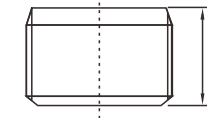
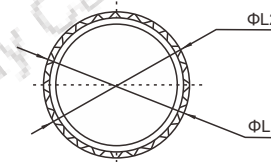
Type	basic dimensions (mm)									
	D	H	h	R	R1	$\alpha 1^\circ$	$\alpha^\circ$	$\beta^\circ$	a	e
AC1215	12	15	10	2	2.5	18	76	18	3	1.5
AC1418	14	18	12	2.5	3	20	75	18	3.5	1.5
AC1621	16	21	13.5	2.5	3	20	70	18	4	1.8
AC1924	19	24	15	3.5	3	20	70	18	4.5	2
AC2230	22	30	17	3.5	3	18	61.5	18	4.5	2

### Type ZA Conical Buttons



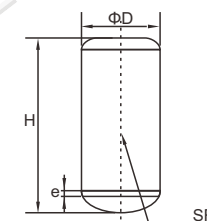
Type	basic dimensions (mm)						
	D	H	h	R	$\alpha^\circ$	$\beta^\circ$	e
ZA-00002	9	14	8	2.5	52°15'	45	0.5
ZA-99010	10	12	7	/	70°	20	1
ZA-1418	14	18.5	10	3.6		18	1.5
ZA1625	16	25	15.5	4	60°	18	1.8
ZA1931	19	31	16	4	50°	18	2

### Insert Bits



Type	basic dimensions (mm)		
	$\Phi L1$	$\Phi L2$	H
$\Phi 8$	8	7.5	5
$\Phi 10$	10	9.5	5.5
$\Phi 14$	14	13	6
$\Phi 18$	18	17	8
$\Phi 25$	25	23.5	10

### Buttons



Type	basic dimensions (mm)			
	D	H	SR	e
AQ0810	8.00	10.00	4.60	1.20
AQ0914	9.00	14.00	4.00	1.20
AQ1010	10.00	10.00	5.20	1.20
AQ1116	11.00	16.00	5.60	1.20
AQ1212	12.00	12.50	6.20	1.50
AQ1313	13.00	13.50	6.60	1.50
AQ1415	14.00	15.00	7.40	1.50
AQ1622	16.00	22.00	5.00	1.50
AQ1822	18.00	22.00	4.00	1.80
AQ1924	19.00	24.00	10.50	2.00
AQ2030	20.00	30.30	10.00	2.00



# Carbide For Grinders / Attritors, or sand mills

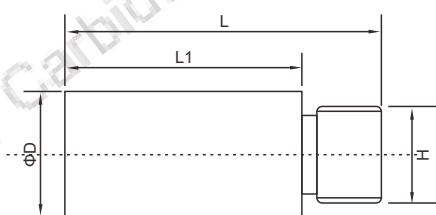
## Grinding Rotor

The grinder rotor is revolving arms for horizontal or vertical grinding attractor, whose stationary tank has excellent cooling capability during the grinding process.



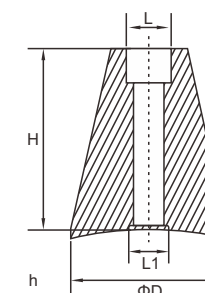
## Pinsr

Pins is installed on the grinder rotor, mainly used for mixing, dispersing to produce ultrafine materials by adding aqueous solvent as grinding aid. This ultrafine and highly dispersed mixture is commonly used with advanced sintering processes to produce cemented alloys or ceramics of very high impact resistant, corrosion resistant and wear resistant.



### basic dimensions (mm)

Diameter(OD)	Length(L)	TAPS
Φ12	35	M10
Φ14	58	M12
Φ16	48	M12
Φ30	108	M16

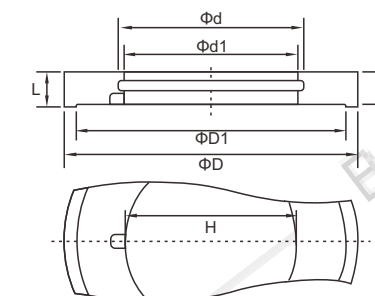


### basic dimensions (mm)

L	L1	ΦD	H
47	23	12	55
60	26	16	60
75	30	24	75
82	46	38	90

## Precision Sealing Rings For Grinding Machines

The special seal rings for grinding machines, are produced with tight dimensional tolerance, are very small, the corrosion resistance and rare element are added in the process formula, the sealing performance is more lasting, and the strength and impact toughness are good, the wear resistance is good, the service life is long. It has strong hardness and high bending strength.



### basic dimensions (mm)

Outer Diameter(OD)	Inner Diameter(ID)	Thickness
Φ80	Φ41	4
Φ120	Φ100	10
Φ149	Φ105	15
Φ174	Φ132	16

# Application Solutions

## High Velocity Oxygen Fuel Spraying Coating

### Technical Advantages:

- \* Three working mode: Economic, Superior, Ultra (see below table for comparison of coating properties and DE)
- \* More uniform coating structure and high density (porosity less than 0.2%)
- \* Less or none decarb (undetectable by XRD)
- \* Higher coating hardness (greater than 1600 HV0.3), less variations thru the coating areas ( 50-60 HV vs. 150-200 HV for conventional HVOF)
- \* More wear resistant
- \* Higher toughness and cavitation resistant properties
- \* gas tight with 50 um thick WC coating under 200 MPa nitrogen gas
- \* higher spray rate: 5-10 um/pass
- \* coatings defect can be repaired locally

## Microstructure and Properties of KLT Coatings

Spray gun	Hv300 hardness HV0.3	Porosity%	K1C Fracture toughness K1C	Ratio of W2C/WC
KLT	1,326±98	0.3	5.97±0.7	0
2 <sup>nd</sup>	1,289±108	0.6	4.87±0.6	0.12
1 <sup>st</sup>	1,047±112	1.7	3.01±0.6	0.7

WC-10Co-4Cr coating properties	HVOF	Three working modes of KLT gun economic superior ultra		
		Economic Mode	High Performance Mode	Ultra High Performance Mode
Deposition rate, %	40-55	60-77	48-58	
Hardness, HV0.3	1050-1250	1050-1250	1050-1350	1450-1700
Youngs Modulus, GPa	300	400	450	
Micro Porosity, %	<0.8	<0.8	<0.5	
Bond strength, MPa(PSI)	80(12000)+			
μ m(μ in.) Surface finish, kas-sprayed	3.5-4.5(150-180)		1-3.2(40-130)	

## Applications and Examples

Oil drilling, oil gas and refining, energy engineering ( hydro-, fossil fuel- , nuclear power generation ) , stee industry , metallurgy , light industry , paper mills , printing industry.

## Examples of Coating Application

Mud rotor, piston rod, pump axle, ball valves, gate valves, impellers, blades, guide vanes, bushings of bottom rings, needles, sealing ring, storage tank, heat exchanger, water cooling tubes, catalyst tower, gate, pump case and cover.

# Contrast Table of Hardness in Common Use

(HRC)	(HRA)	(HV)	(HB30D2)	(HS)
	93.5	1850		
82.0	93.0	1800		
80.5	92.5	1700		
80.0	92.0	1600		
79.0	91.5	1550		
78.0	91.0	1500		
77.0	90.5	1450		
76.0	90.0	1400		
75.0	89.5	1350		
74.0	89.0	1300		
73.0	88.5	1250		
72.0	88.0	1200		
71.5	87.5	1150		
71.0	87.0	1140		
70.0	86.6	1037		
69.5	86.3	1017		
69.0	86.1	997		
68.5	85.8	978		
68.0	85.5	959		96.6
67.5	85.2	941		95.6
67.0	85.0	923		94.6
66.5	84.7	906		93.5
66.0	84.4	889		92.6
65.5	84.1	872		91.5
65.0	83.9	856		90.5
64.5	83.6	840		89.4
64.6	83.3	825		88.4
63.5	83.1	810		87.6
63.0	82.8	795		86.5
62.5	82.5	780		85.7
62.0	82.2	766		84.8

(HRC)	(HRA)	(HV)	(HB30D2)	(HS)
61.5	82.0	752		84.0
61.0	81.7	739		83.1
60.5	81.4	726		82.2
60.0	81.2	712		81.4
59.5	80.9	700		80.6
59.0	80.6	688		79.7
58.5	80.3	676		78.9
58.0	80.1	664		78.1
57.5	79.8	653		77.2
57.0	79.5	642		76.2
56.5	79.3	631		75.6
56.0	79.0	620		74.9
55.5	78.7	609		74.2
55.0	78.5	599		73.5
54.5	78.2	589		72.6
54.0	77.9	579		71.9
53.5	77.7	570		71.2
53.0	77.4	561		70.5
52.5	77.1	551		69.8
52.0	76.9	543		69.1
51.5	76.6	534		68.5
51.0	76.3	525	501	67.7
50.5	76.1	517	494	67.0
50.0	75.8	509	488	66.3
49.5	75.5	501	481	
49.0	75.3	493	474	65.0
48.5	75.0	485	468	
48.0	74.7	478	461	63.7
47.5	74.5	470	455	
47.0	74.2	463	449	62.3
46.5	73.9	456	442	



# Contrast Table of Hardness in Common Use

(HRC)	(HRA)	(HV)	(HB30D2)	(HS)
46.0	73.7	449	436	61.0
45.5	73.4	443	430	
45.0	73.2	436	424	59.7
44.5	72.9	429	418	
44.0	72.6	423	413	58.4
43.5	72.4	417	407	
43.0	72.1	411	401	57.1
42.5	71.8	405	396	
42.0	71.6	399	391	55.9
41.5	71.3	393	385	
41.0	71.1	388	380	54.7
40.5	70.8	382	375	
40.0	70.5	377	370	53.5
39.5	70.3	372	365	
39.0	70.0	367	360	52.3
38.5	69.7	362	355	
38.0	69.5	357	350	51.1
37.5	69.2	352	345	
37.0	69.0	347	341	50.0
36.5	68.7	342	336	
36.0	68.4	338	332	48.8
35.5	68.2	333	327	
35.0	67.9	329	323	47.8
34.5	67.7	324	318	
34.0	67.4	320	314	46.6
33.5	67.1	316	310	
33.0	66.9	312	306	45.6
32.5	66.6	308	302	
32.0	66.4	304	298	44.5
31.5	66.1	300	294	
31.0	65.8	296	291	43.5

(HRC)	(HRA)	(HV)	(HB30D2)	(HS)
30.5	65.6	292	287	
30.0	65.3	289	283	42.5
29.5	65.1	285	280	
29.0	64.8	281	276	41.6
28.5	64.6	278	273	
28.0	64.3	274	269	40.6
27.5	64.0	271	266	
27.0	63.8	268	263	39.7
26.5	63.5	264	260	
26.0	63.3	261	257	38.8
25.5	63.0	258	254	
25.0	62.8	255	251	37.9
24.5	62.5	252	248	
24.0	62.2	249	245	37.0
23.5	62.0	246	242	
23.0	61.7	243	240	36.3
22.5	61.5	240	237	
22.0	61.2	237	234	35.5
21.5	61.0	234	232	
21.0	60.7	231	229	34.7
20.5	60.4	229	227	
20.0	60.2	226	225	34.0
19.5	59.9	223	222	
19.0	59.7	221	220	33.2
18.5	59.4	218	218	
18.0	59.2	216	216	32.6
17.5	58.9	214	214	